Computer Systems Design and Related Services

(NAICS 5415)

SIGNIFICANT POINTS

- The computer systems design and related services industry is expected to be one of the top 10 fastest growing industries in the economy, adding more than 600,000 jobs between 2002 and 2012.
- Professional and related workers enjoy the best prospects, reflecting continuing demand for higher level skills needed to keep up with changes in technology.
- Computer specialists account for 53 percent of all employees in this industry.

Nature of the Industry

All organizations today rely on computer and information technology to conduct business and operate more efficiently. Often, however, these institutions do not have the internal resources to effectively implement new technologies or satisfy their changing needs. When this happens, they turn to the computer systems design and related services industry to meet their specialized needs on a contract or customer basis. Firms may enlist the services of one of nearly 146,000 establishments in the computer systems design and related services industry for help with a particular project or problem, such as setting up a secure Web site or establishing a marketplace online. Alternatively, they may choose to contract out one or more activities, such as the management of their onsite data center or help-desk support, to a computer services firm.

Services provided by this industry include custom computer programming services; computer systems design services; computer facilities management services, including computer systems or data processing facilities support services for clients; and other computer-related services such as disaster recovery services and software installation. Computer training contractors, however, are grouped with educational services, and establishments that manufacture and sell computer equipment are included with electronic equipment manufacturing. Establishments primarily engaged in providing computer data processing services at their own facility for others are classified in the data processing, hosting, and related services industry. Producers of packaged software and Internet-based software are part of the software publishers industry, which is discussed elsewhere in the *Career Guide*. Telecommunications services, including cable Internet providers, also are covered in a separate *Career Guide* statement.

Professional services offered within this industry include custom programming, computer systems design, and other specialized consulting. Custom programming establishments write, modify, test, and support software to meet the needs of a particular customer. These service firms may be hired to code large programs or install a software package on a user's system and customize it to the user's specific needs. Programming service firms also may update or re-engineer existing systems. Systems design services firms plan and design computer systems that integrate computer hardware, software, and communications technologies. The hardware and software components of the system may be provided by the design firm as part of integrated services or may be provided by third parties or vendors. These firms often install the system and train and support its users.

Computer facilities management services usually are offered at the customer's site. Establishments offering these services provide onsite management and operation of clients' computer systems and data processing facilities, as well as facilities support services.

Electronic business ("e-business") is any process that a business organization conducts over a computer-mediated network. Electronic commerce ("e-commerce") is that part of e-business that involves the buying and selling of goods and services online. With the growth of the Internet and the expansion of electronic commerce, some service firms specialize in developing and maintaining Web sites for client companies. Others create and maintain corporate intranets or self-contained internal networks linking multiple users within an organization by means of Internet technology. These firms design sophisticated computer networks, assist with upgrades or conversions, custom design special programming features for clients and engage in continual maintenance. They help clients select the right hardware and software products for a particular project, and then develop, install, and implement the system, as well as train the client's users. Service firms also offer consulting services for any stages of development throughout the entire process, from design and content development to administration and maintenance of site security.

The widespread use of the Internet and intranets also has resulted in an increased focus on security. The robust growth of electronic commerce highlights this concern, as firms seek to attract as many potential customers as possible to their Web sites. Security threats range from damaging computer viruses to online credit card fraud. Services contracted out to security consulting firms include analyzing vulnerability, managing firewalls, and providing intrusion and antivirus protection. Information technology (IT) security has two important aspects: Computer security, making software and networks safe; and homeland security, keeping track of people and information. The need for more secure Internet and Intranet sites to ensure protection for individuals' personal information, and for companies and

banks to protect their funds and infrastructure, has created a new demand for cyberspace security professionals.

Working Conditions

Most workers in this industry work in clean, quiet offices. Those in facilities management and maintenance may work in computer operations centers. Given the technology available today, however, more work can be done from remote locations using modems, fax machines, e-mail, and especially the Internet. For example, systems analysts may work from home, with their computers linked directly to computers at a financial services firm. Although they often relocate to a customer's place of business while working on a project, programmers and consultants may actually perform work from locations offsite. Even technical support personnel can tap into a customer's computer remotely in order to identify and fix problems.

Only about 6 percent of the workers in computer systems design and related services firms work part time, compared with 16 percent of workers throughout all industries. Many workers in this industry work more than the standard 40-hour workweek—about 1 in 5 work 50 or more hours a week. For many professionals and technical specialists, evening or weekend work is common to meet deadlines or solve problems. Professionals working for large establishments may have less freedom in planning their schedule than do consultants for very small firms, whose work may be more varied.

Those who work with personal computers for extended periods may experience musculoskeletal strain, eye problems, stress, or repetitive motion illnesses, such as carpal tunnel syndrome.

Employment

In 2002, there were about 1. 2 million wage and salary jobs, and an additional 116,000 self-employed workers, making the industry one of the largest in the economy. Most self-employed workers are independent consultants.

While the industry has both large and small firms, the average establishment in computer systems design and related services is relatively small; over 78 percent of establishments employed fewer than 5 workers. The majority of jobs, however, are found in establishments that employ 50 or more workers (chart). Many small establishments in the industry are startup firms that hope to capitalize on a market niche.

Relative to the rest of the economy, there are significantly fewer workers 45 years of age and older; this industry's workforce remains younger than most, with large proportions of workers in the 25 to 44 age range (table 1). This reflects the industry's explosive growth in employment since the early 1980s. The huge increase in employment afforded thousands of opportunities to younger workers possessing the newest technological skills.

Occupations in the Industry

Providing a wide array of information services to clients requires a diverse and well-educated workforce. The majority of workers in computer systems design and related services are professional and related workers, such as computer systems analysts, computer engineers, and computer programmers (table 2). This occupational group accounts for 59 percent of the jobs in the industry, reflecting the emphasis on high-level technical skills and creativity. By 2012, the share of professional and related occupations is expected to be even greater, while the share of office and administrative support jobs, currently accounting for 14 percent of industry employment, is projected to fall.

Programmers write, test, and maintain the detailed instructions, called programs or software, that computers must follow to perform their functions. These specialized programs tell the computer what to do—for example, which information to identify and access, how to process it, and what equipment to use. Custom programmers write these commands by breaking down each step into a logical series, converting specifications into a language the computer understands. While some still work with traditional programming languages like COBOL, object-oriented programming languages, such as C++ and Java, computer-aided software engineering (CASE) tools, and artificial intelligence shells now are being used to create and maintain programs. These languages and tools allow portions of code to be reused in programs that require similar routines. Many programmers also customize a package to clients' specific needs or create better packages.

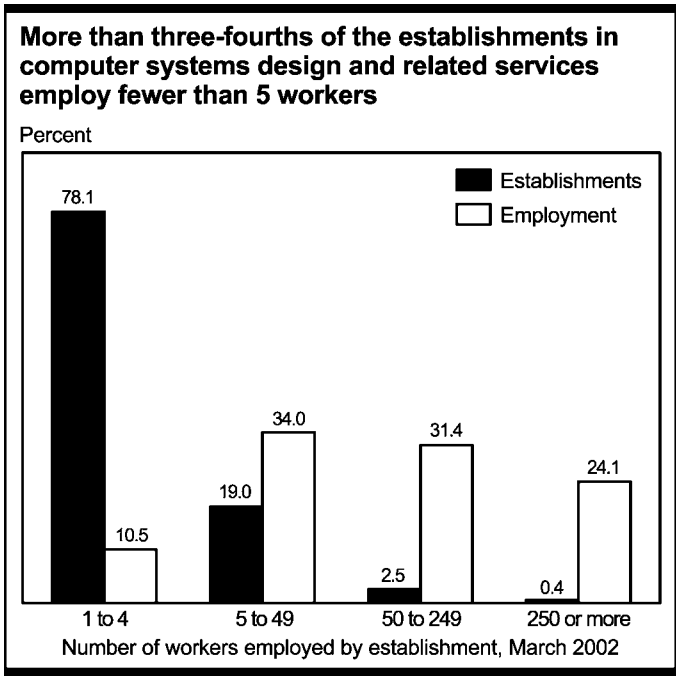

Table 1. Percent distribution of employment in computer systems design and related services by age group, 2002

Age group	Computer systems design and related services	All Industries
Total	100.0%	100.0%
16-19	0.8	4.8
20-24	6.1	9.9
25-34	37.3	21.6
35-44	30.4	26.3
45-54	18.1	22.9
55-64	6.5	11.4
65 and older	0.7	3.2

Computer engineers design, develop, test, and evaluate computer hardware and related equipment, software programs, and systems. Although programmers write and support programs in new languages, much of the design and development now is the responsibility of *software engineers* or *software developers*. (See *Career Guide* statement on software publishers.) Software engineers in systems design and related services must possess strong programming skills, but are more concerned with developing algorithms and analyzing and solving programming problems for specific network systems than with actually writing code. *Computer systems software engineers* are primarily engaged in writing, modifying, testing, and developing software to meet the needs of a particular customer. They develop software systems for control and automation in manufacturing, business, and other areas.

Professionals involved in analyzing and solving problems include *systems analysts*, who study business, scientific, or engineering data processing problems and design new flows of information. Computers need to be connected to each other and to a control server to allow communication among users, thus enhancing use of their computing power. Systems analysts tie together hardware and software to give an organization the maximum benefit from its investment in machines, personnel, and business processes. To do this, they may design entirely new systems or add a single new software application to harness more of the computer's power. They use data modeling, structured analysis, information engineering, and other methods. Systems analysts prepare charts for programmers to follow for proper coding and also perform cost-benefit analyses to help management evaluate the system. They ensure that the system performs to its specifications and test it thoroughly.

Database administrators determine ways to organize and store data and work with database management systems software. They set up computer databases and test and coordinate changes to them. Because they also may be responsible for design implementation and system security, database administrators often plan and coordinate security measures.

Computer and information scientists work as theorists, researchers, or inventors. They apply a higher level of theoretical expertise and innovation and develop solutions to complex problems relating to computer hardware and software. Computer and information scientists with advanced backgrounds in security may be employed as cyberspace security specialists in disaster recovery situations or in custom security software installation.

Computer support specialists provide technical assistance, support, and advice to customers and users. This group of occupations includes workers with a variety of titles, such as *technical support specialists* and *help-desk technicians*. These troubleshooters interpret problems, and provide technical support for hardware, software, and systems. Support specialists may work either within a company or other organization or directly for a computer hardware and software vendor. They answer telephone calls, analyze problems using automated diagnostic programs, and resolve recurrent difficulties encountered by users.

Other computer specialists include a wide range of related professionals who specialize in operation, analysis, education, application, or design for a particular piece of the system. Many are involved in the design, testing, and evaluation of network systems, such as local area networks (LANs), wide area networks (WANs), Internet, and other data communications systems. Specialty occupations reflect an emphasis on client-server applications and end-user support; however, occupational titles shift rapidly to reflect new developments in technology.

Network systems and data communications analysts, for example, design, and evaluate network systems, such as LANs, WANs, and the Internet. They perform network modeling, analysis, and planning and may deal with the interfacing of computer and communications equipment. With the explosive growth of the Internet, this group includes a variety of occupations relating to design, development, and maintenance of Web sites and their servers. *Web developers* are responsible for day-to-day site design and creation. *Webmasters* are responsible for the technical aspects of the Web site, including performance issues such as speed of access, and for approving site content.

Network or *computer systems administrators* install, configure, and support an organization's LAN, WAN, network segment, or Internet system. They maintain network hardware and software, analyze problems, and monitor the network to ensure availability to system users. Administrators also may plan, coordinate, and implement network security measures. In some organizations, *computer security specialists* are responsible for the organization's information security.

Computer and information systems managers direct the work of systems analysts, computer programmers, and other computer-related workers. They analyze the computer and information needs of their organization and determine personnel and equipment requirements. These managers plan and coordinate activities such as the installation and upgrading of hardware and software; programming and systems design; development of computer networks; and implementation of Internet and intranet sites.

Due, in part, to the robust growth in electronic commerce, a growing number of other workers in this industry is in sales and related occupations. In order to compete successfully and gain customers and clients in the online world, the presentation and features of Web sites and other Web-related content becomes increasingly important. The marketing and sales workers employed in this industry are responsible for promoting and selling the products and services provided by the various sectors of this industry.

Training and Advancement

Occupations in the computer and data processing services industry require varying levels of education. The level of education and type of training required depend on employers' needs. One factor affecting these needs is changes in technology. In the past, there has been strong demand for workers with skills related to the Internet, sending employers scrambling to find workers capable of implementing "hot" new technologies. As the job market for computer specialists has become more competitive, employers have become more selective in the hiring process. Formerly, employers might hire an applicant with less computer-related education or experience in efforts to keep up with the fast growth in this industry. Growth in the numbers of qualified workers, as well as shrinking of the technology job market from its

Table 2. Employment of wage and salary workers in computer systems design and related services by occupation, 2002 and projected change, 2002-12
(Employment in thousands)

Occupation	Employment, 2002 Number	Employment, 2002 Percent	Percent change, 2002-12
All occupations	1,163	100.0	54.6
Management, business, and financial occupations	203	17.5	59.3
Chief executives	8	0.7	52.6
General and operations managers	32	2.7	48.4
Marketing and sales managers	16	1.3	74.5
Sales managers	8	0.7	65.5
Computer and information systems managers	35	3.0	68.8
Financial managers	8	0.7	52.6
Engineering managers	7	0.6	52.6
All other managers	7	0.6	52.6
All other business operations specialists	16	1.4	67.9
Management analysts	24	2.1	68.8
Accountants and auditors	9	0.8	51.9
Professional and related occupations	689	59.3	60.6
Computer programmers	124	10.7	33.2
Computer software engineers, applications	121	10.4	69.9
Computer software engineers, systems software	70	6.1	86.9
Computer support specialists	86	7.4	52.6
Computer systems analysts	100	8.6	68.4
Database administrators	15	1.3	74.8
Network and computer systems administrators	40	3.4	68.4
Network systems and data communications analysts	24	2.0	91.4
All other computer specialists	27	2.4	65.9
Computer hardware engineers	10	0.8	52.9
Technical writers	7	0.6	52.6
Sales and related occupations	67	5.8	38.1
Sales representatives, wholesale and manufacturing, technical and scientific products	20	1.7	22.1
All other sales and related workers	18	1.6	52.6
Office and administrative support occupations	165	14.2	33.1
First-line supervisors managers of office and administrative support workers	11	0.9	30.9
Bookkeeping, accounting, and auditing clerks	14	1.2	30.2
Customer service representatives	32	2.8	52.6
Receptionists and information clerks	6	0.5	52.6
Secretaries and administrative assistants	31.0	31	2.7
Computer operators	8	0.7	3.5
Data entry keyers	8	0.7	10.3
Office clerks, general	20	1.7	32.9
Installation, maintenance, and repair occupations	21	1.8	45.6
Computer, automated teller, and office machine repairers	6	0.6	37.4
Telecommunications equipment installers and repairers, except line installers	6	0.5	45.0

NOTE: May not add to totals due to omission of occupations with small employment.

peak in 2000, has made employers more selective, hiring those candidates with more education and more experience. Another factor driving employers' needs is the timeframe within which a project must be completed.

Computer programmers commonly hold a bachelor's degree; however, there are no universal educational requirements. Some hold a degree in computer science, mathematics, or information systems, while others have taken special courses in computer programming to supplement their study in fields such as accounting, inventory control, or other areas of business. Because employers' needs are so varied, a 2-year degree or certificate may be sufficient for some positions, so long as applicants possess the right technical skills.

Most computer systems analysts and computer engineers, on the other hand, usually have a bachelor's or higher degree and work experience. Many hold advanced degrees in technical fields or a master's degree in business administration (MBA) with a concentration in information systems, and are specialists in their fields. For systems analyst, programmer-analyst, or even database administrator positions, many employers seek applicants who have a bachelor's degree in computer science, information science, or management information systems (MIS). For computer and information scientists, a doctoral degree generally is required due to the highly technical nature of their work. For some networks systems and data communication analysts, such as Webmasters, an associate degree or certificate generally is sufficient, although more advanced positions might require a computer-related bachelor's degree.

Persons interested in becoming a computer support specialist generally need only an associate degree in a computer-related field, as well as significant hands-on experience with computers. They also must possess strong problem-solving and analytical skills as well as excellent communication skills, because troubleshooting and helping others are such a vital part of the job. And because there is constant interaction on the job with other computer personnel, customers, or employees, computer support specialists must be able to communicate effectively on paper, via e-mail, or in person. They also must possess strong writing skills when preparing manuals for employees and customers. As technology continues to improve, computer support specialists must constantly strive to stay up to date and acquire new skills if they wish to remain in the field.

Computer and information systems managers usually require a bachelor's degree in a computer-related occupation, combined with work experience. Employers, though, often prefer a graduate degree, especially an MBA with technology as a core component.

The size of the firm and the local demand for workers also may influence training requirements for specific jobs. Smaller firms may be willing to train informally on the job, whereas larger organizations may pay for formal training or higher education. For example, many of the marketing and sales workers are able to secure entry-level jobs with little technical knowledge but quickly learn the technical knowledge necessary for their company and product. With more formal education, employees may advance to completely different jobs within the industry. Education or training in a specialty area may provide new opportunities for the worker and allow the establishment to offer new services.

As technological advances in the computer field continue, employers in all areas demand a higher level of skill and expertise. Employers, hardware and software vendors, colleges and universities, private training institutions, or professional computing societies offer continuing education and professional development seminars. Technical or professional certification is a way by which employers ensure the competency or quality of computer professionals. Certification can be obtained voluntarily, though many vendors now offer or even require professionals who work with their products to be certified.

Voluntary certification is available through organizations such as the Institute of Certification and Computing Professionals (ICCP) and the Institute of Electrical and Electronics Engineers (IEEE) Computer Society. Although professional certification is not mandatory, it may provide a jobseeker a competitive advantage. ICCP offers the Certified Computing Professional (CCP) designation to those who have at least 2 years of experience and a college degree. Candidates must pass a core examination testing general knowledge, plus exams in two specialty areas, or in a specialty area and two computer programming languages. The IEEE Computer Society recently created a certification process for software engineers who pass an examination.

Entry-level computer programmers usually start working with an experienced programmer, updating existing code, generating lines of one portion of a larger program, or writing relatively simple programs. They then advance to more difficult programming and may become project supervisors, or move into higher management positions within the organization. Many programmers who work closely with systems analysts advance to systems analyst positions.

Systems analysts may begin working with experienced analysts or may deal with only small systems or one aspect of a system. They also may move into supervisory positions as they gain further education or work experience. Systems analysts who work with one type of system, or one aspect or application of a system, can become specialty consultants or move into management positions. Computer engineers and scientists who show leadership ability also can become project managers or advance into management positions, such as manager of information systems or chief information officer. Technical support specialists may advance by developing expertise in an area that leads to other opportunities. For example, those responsible for network support may advance into network administration or network security.

Consulting is an attractive option for experienced workers who do not wish to advance to management positions, or who would rather continue to work with hands-on applications or in a particular specialty. These workers may market their services on their own, under contract as specialized consultants, or with an organization that provides consulting services to outside clients. Many of the largest firms today have subsidiaries that offer specialized services to the host company and to outside clients. Large consulting and computer firms often will hire inexperienced college graduates and put them through intensive, company-based programs that train them to provide such services.

Many experienced workers also have opportunities to move into sales positions as they gain knowledge of specific products. The emergence of various forms of electronic commerce has resulted in efforts by technical workers to make Web sites and content appealing to potential customers, so that they become comfortable conducting transactions over the Internet. Computer programmers who adapt prepackaged software for accounting organizations may use their specialized knowledge to sell such products to similar firms.

Earnings

Employees in the computer systems design and related services industry generally command higher earnings than the national average. All production or nonsupervisory workers in the industry averaged $1,103 a week in 2002, significantly higher than the average of $506 for all industries. This reflects the concentration of professionals and specialists who often are highly compensated for their specialized skills or expertise. Given the pace at which technology advances in this industry, earnings can be driven by demand for specific skills or experience. Workers in segments of the industry that offer only professional services have even higher average earnings because there are fewer less skilled, lower paid workers in these segments. Earnings in selected occupations in computer systems design and related services appear in table 3.

As one might expect, education and experience influence earnings as well. For example, annual earnings of computer software engineers ranged from less than $43,750 for the lowest 10 percent to more than $113,590 for the highest 10 percent in 2002. Managers usually earn more because they have been on the job longer and are more experienced than their staffs, but their salaries, too, can vary by level and experience. Accordingly, annual earnings of computer and information systems managers ranged from less than $55,620 for the lowest 10 percent to more than $145,600 for the highest 10 percent in 2002. Earnings also are affected by other factors, such as size, location, and type of establishment, hours and responsibilities of the employee, and level of sales.

Unionization is rare in the computer systems design and related services industry; fewer than 2 percent of all workers are union members or are covered by union contracts, compared with 15 percent of workers throughout private industry.

Outlook

The computer systems design and related services industry grew dramatically throughout the 1990s, as employment more than doubled. And despite recent job losses in certain sectors, this remains one of the 10 fastest growing industries in the Nation. Wage and salary employment is expected to grow 55 percent by the year 2012, compared with only 16 percent growth projected for the entire economy. Given the rate at which the computer systems design and related services industry is expected to grow and the increasing complexity of technology available, job opportunities will be extremely favorable for most workers. The best opportunities will be for professional and related occupations, reflecting their growth and the continuing demand for higher level skills to keep up with changes in technology.

An increasing reliance on information technology, combined with falling prices of computers and related hardware, means that individuals and organizations will continue to turn to computer systems design and related services firms to maximize the

Table 3. Median hourly earnings of the largest occupations in computer systems design and related services, 2002

Occupation	Computer systems design and related services	All industries
General and operations managers	$53.64	$32.80
Computer and information systems managers	45.31	40.98
Computer software engineers, systems software	35.32	35.60
Computer software engineers, applications	34.56	34.09
Computer systems analysts	32.54	30.24
Management analysts	31.79	29.01
Computer programmers	31.56	28.98
Network and computer systems administrators	28.27	26.35
Computer support specialists	19.76	18.80
Customer service representatives	14.01	12.62

return on their investments in equipment and to fulfill their growing computing needs. Such needs include the expansion of electronic commerce, a growing reliance on the Internet, faster and more efficient internal and external communication, and the implementation of new technologies and applications. With increasing global competition and rising costs, organizations must be able to obtain and manage the latest information in order to make business decisions. At the same time, employment growth may be tempered somewhat by an increase in contracting out more routine services abroad, where labor costs are lower, as companies strive to remain competitive. For example, firms have been able to cut costs by shifting more support services operations abroad to countries with highly educated workers who have strong technical skills. However, the trend towards contracting out work will adversely affect employment of only certain types of workers, such as programmers and computer support specialists, because much of the work integrating and designing systems needs to be done onsite.

Within the computer systems design and related services industry, projected growth varies by sector. The demand for networking and the need to integrate new hardware, software, and communications technologies will drive the demand for consulting and integration. A need for more customized applications development and support and services to assist users will drive demand for applications development and facilities support services. And, as more individuals and organizations are conducting business electronically, the importance of maintaining system and network security will increase. Recent events have made society more conscious of the vulnerability of technology and the Internet. The increasing need for security related to information technology will expand employment opportunities for individuals involved in cyberspace security services such as disaster recovery services, custom security programming, and security software installation services.

This increased need for security will help to create more jobs in the computer systems design and related services industry. Security specialists will be employed more often to make judgments on a system's vulnerability. Custom programmers and designers will be asked to help develop new antivirus software, programs, and procedures as preemptive measures to keep "hackers" out and systems virus-free. Therefore, employment of security analysts and consultants with security experience and expertise should rise rapidly.

New growth areas will continue to arise from rapidly evolving technologies and business forces. The expansion of the Internet, the proliferation of Web sites, and "mobile" technology such as wireless Internet have created a demand for a wide variety of new products and services, including online services, network design services, and a range of specialized consulting. For example, the expansion of the wireless Internet, known as WiFi, brings a new aspect of mobility to information technology. This new technology will allow people to stay connected anywhere anytime, in restaurants, shops, hotels, and even on airplanes. As individuals and businesses rely more on more compact, handheld computers and wireless Internet connections, it will be necessary to integrate the current computer systems with this more mobile new technology. The expansion of this technology in the next 10 years will lead to an increased need for "mobility consultants" or service firms that can help companies design and integrate computer systems so that they will be compatible with one another.

The way the Internet is used is constantly changing, along with the products, services, and personnel required to support new applications. Expanding electronic commerce changed the way companies transact business, enabling markets to expand and an increasing array of services to be provided to customers. And, as the amount of computer-stored information grows, organizations will continue to look for ways to tap the full potential of their vast stores of data. Demand for an even wider array of services should increase as companies continue to expand their capabilities, integrate new technologies, and develop new applications. As there are more innovations and new technology is released, there will be a steady need for computer systems facilities support services to provide assistance to the users.

Given the increasingly widespread use of information technologies and the overall rate of growth expected for the entire industry, most occupations should continue to grow rapidly, although some will do so faster than others. As firms continue to install sophisticated computer networks, set up Internet and intranet sites, and engage in electronic commerce, the most rapid growth will occur among computer specialists such as systems analysts, network and computer systems administrators, computer support specialists, and computer and information systems managers. Employment of programmers should continue to expand, but more slowly than that of other occupations, as the proportion of programmers decreases in relation to other computer specialists.

Sources of Additional Information

Information regarding certification of computer professionals is available from:

- Institute for Certification of Computing Professionals , 2350 E. Devon Ave. , Suite 115, Des Plaines, IL 60018. Internet: **http://www. iccp. org**

Further information about computer careers is available from:

- Association for Computing Machinery, 1515 Broadway, New York, NY 10036.
  Internet: **http://www. acm. org**
- IEEE Computer Society, Headquarters Office, 1730 Massachusetts Ave. NW. , Washington, DC 20036-1992.
  Internet: **http://www. computer. org/certification**
- National Workforce Center for Emerging Technologies, 3000 Landerholm Circle SE. , Bellevue, WA 98007.
  Internet: **http://www. nwcet. org**

Information on the following occupations can be found in the 2004-05 *Occupational Outlook Handbook*:

- Computer and information systems managers
- Computer operators
- Computer programmers
- Computer software engineers
- Computer support specialists and systems administrators
- Computer systems analysts, database administrators, and computer scientists